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C O N F I D E N T I A L

U. S. NAVAL ORDNANCE TEST STATION

W. W. Hollister, Capt., USN
Commander

Wm. B. McLean, Ph.D.
Technical Director

NOTS 1918

TPR 206

PRX PROGRESS
FOR QUARTER ENDING 31 DECEMBER 1957

By

The Explosives Division

Propellants and Explosives Department

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C O N F I D E N T I A L

FOREWORD

This report is an informal account of progress on the plastic-bonded explosives program and of miscellaneous service which it appeared necessary to perform for groups outside the Explosives Division. Most of the activities described are supported by MOTS Task Assignment 43008/02 and Local Project 992. Since the report is released at the working level, the material it contains may or may not reflect the official views of the Station. Much of the material is of an exploratory nature and may or may not be confirmed by further investigation.

K. S. SKAAR
Head, Explosives Division

Released under
the authority of:
WM. B. McLEAN
Technical Director

ABSTRACT*

Four papers describe successively (and supply data on):
Coagulation Procedures for PEKN-1 Slurries, Nylon Bonded HMX
Combinations, High-Temperature-Resistant Explosive Compositions,
and Improvement of the Bulk Density of PEKN-2 Molding Powder.

Abstracts of the individual papers appear in the Contents.

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Two methods are described for improving agglomeration in PEKN-1 slurries. One procedure involves the addition of nitrate salts to the quench water to promote nylon coagulation; the other, treatment of the aluminum flake to reduce its segregation tendencies. Various inorganic and organic compounds were incorporated, either as quench additives or as coatings for the phosphated metal. These materials were found to produce marked effects on the properties of the coagulant.

Impact-sensitivity tests conducted on samples showing optimum agglomeration characteristics gave values approximating those for Composition B.

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by: C. W. Falterman, H. D. Stanton, H. J. Gryting, and
K. S. Skaar

The need for an insensitive explosive with high strength and reasonable detonation velocity prompted investigation of nylon-bonded HMX combinations with higher than 10% nylon. At about 25% nylon, the PEK has a compressive strength of 11,000 psi; it is as insensitive as pressed TNT, and yet it retains explosive properties comparable to Composition B.

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by: C. Douglas Lind, Peter L. Stang, Martin H. Kaufman	

Several high-temperature-resistant explosive compositions were prepared and evaluated. Of these, the HMX/Kel-F 5500 elastomer composition (90/10% by weight) seemed to be most promising.

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by: William Gordon	

A method is described for producing PEKN-2 with a bulk density of approximately 1 g/cc. The method essentially consists of using an inert diluent, toluene, in the binder solution, partially precipitating out the nylon from the binder solution and completing the precipitation and PEK particle-formation in a modified kettle containing a water-methanol and nitric acid solution.

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ABBREVIATIONS AND SYMBOLS

cyclotol	RDX/TNT (75/25 % by wt.)
det pt	detonation point
ρ	density
det vel or D	detonation velocity
HBX-1	standard explosive mix
HMX	cyclotetramethylenetetranitramine
IS	impact sensitivity
PBX	plastic-bonded explosive
9404 PBX	Los Alamos PBX
RDX	cyclotrimethylenetrinitramine
TMD	theoretical maximum density

COAGULATION PROCEDURES FOR PEKN-1 SLURRIES

Barbara A. Stott and Martin H. Kaufman

BACKGROUND

Production of PEKN-1 molding powder by the slurry process involves two main steps: first, mixing together RDX and aluminum flake in a lacquer of nylon in methanol and, second, agglomerating the solids by the addition of an aqueous quench. The ideal result after suitable size breakdown and removal of liquids is a homogeneous mixture or molding powder of nylon-coated RDX and metal particles, which can then be pressed to the desired shape and size.

Two major difficulties have been encountered in carrying out the slurry process. One is the failure of the nylon to completely coagulate. This results in a milky supernatant liquid, which is difficult to filter, possible loss of nylon from the finished formulation, and possible inefficient coating. The second problem is segregation of the aluminum. The natural floating tendency of finely divided flake aluminum, which leads to greater dispersion, appears to be greatly augmented by the phosphate treatment used to passivate the metal. When the agglomerate of RDX, aluminum, and coagulated nylon is broken up to obtain the desired particle-size, metal flakes stream from the main mass as if electrically repelled. Under some conditions this segregation occurs immediately after addition of the quench liquid, even before attempts are made to reduce particle-size. The net result in any case may be either segregation or loss of up to 40% of the original aluminum content by migration into the aqueous phase.

THE STUDY

The purpose of the present study, therefore, was to find a means of eliminating these two problems, the failure of the nylon to completely coagulate and the tendency of the metal to separate out. Better coating procedures, it was hoped, not only would improve composition and bulk density but also would achieve the maximum desensitization possible in a mixture of this type.

The difficulties described were first approached by introducing various additives to the quench liquid. Extreme effects were noted in many cases. Both inorganic electrolytes and organic liquids were tried, the latter possessing solubility characteristics such that they were miscible with water and exerted negligible or very low solvent action on the PHX constituents.

Nitrate salts at nearly neutral pH values and concentrations ranging from 1 to 2.5 grams per 100 ml were very effective in promoting rapid and complete nylon coagulation. These salts also brought about some reduction in the leafing tendency of aluminum. However, considerable aluminum separation was still encountered when the coagulant was broken down to the desired particle-size. Sodium, ammonium, magnesium, and aluminum nitrates all appeared to be equally beneficial whereas other electrolytes of analogous charge combination, such as sodium iodide or magnesium and aluminum sulfates, either failed to coagulate the nylon completely or caused extreme aluminum segregation or both. Reducing the pH of a sodium nitrate solution to about 2 resulted in immediate and extreme leafing as soon as the quench liquid was introduced.

The organic additives investigated were of little value in promoting complete coagulation or in preventing metal segregation. However, they appeared to cause an instantaneous reduction in particle-size under certain experimental conditions. When combined with a nitrate to obtain better coagulation, they immediately produced homogeneous curds of about 1/16 in. diameter. The phenomenon, although consistent in the laboratory, was difficult to reproduce on a larger scale with the slurry equipment available. Some of the organic additives studied were carbitol acetate, diacetone alcohol, diethylene glycol, methoxytriglycol acetate, dioxane and tetrahydrofuran.

After addition of nitrates to the slurry quench had succeeded in promoting better coagulation, the remaining problem of aluminum segregation was approached by coating the metal with various inorganic salts, surfactants, and resinous materials. Of these, only the latter type proved both effective and practical. It was found that a very thin layer of lacquer grade nitrocellulose applied to the metal flake immediately after phosphating reduced segregation to an extent comparable to that evidenced by unphosphated aluminum. The agglomerate could be macerated in the aqueous quench more than enough to break down particle-size before any substantial quantity of metal was lost.

Another resin which showed promise was Alkydol 170.¹ Undoubtedly still others, which were not investigated because of time limitations, would be equally effective. The two described, Alkydol and nitrocellulose, had the advantage of being acetone soluble. This property permitted direct application after phosphating, since rinse water from the phosphating process could be easily removed by washing the aluminum with acetone, and the resin in acetone solution could then be conveniently introduced. In addition, results indicated that these two resins withstood the solvent action of methanol sufficiently well to prevent their complete removal from the aluminum during the initial stages of the slurry process.

Washes applied to aluminum, which failed to reduce leafing, were those containing the inorganic compounds: chromic acid, potassium dichromate, ammonium nitrate, and sodium silicate. Equally ineffective were solutions of G.E. 60 silicone², Arquad 183³, Armid HT⁴, Duponol G⁵, beta-chloroethyl phosphate, diphenylamine, hydroxylamine, Carbowa 4000⁶, sebacic acid, stearic acid and alpha-hydroxy-decanoic acid. Most of these latter additives, in fact, increased the tendency of the metal to segregate, extreme leafing often occurring even before attempts were made to reduce particle-size. Sodium stearate was the only coating of this type which showed any degree of promise. However, difficulties in its handling and application, plus its possible deleterious effect on physical properties when present in sufficient concentration, led to its rejection in favor of the more easily processed nitrocellulose.

Nylon and lucite precoat were also tried. Both failed to reduce segregation to the desired extent. The nylon, in this case, was undoubtedly removed from the metal surface by the methanol solvent in the slurry.

Since, as has been pointed out, unphosphated flake produced relatively few segregation difficulties, initial attempts were directed toward extracting surface impurities from the unprocessed aluminum and redepositing them on freshly phosphated flake. Microscopic examination had shown no readily observable size or

¹Alkydol Laboratories, Inc., Cicero, Ill.

²General Electric Co., Waterford, N. Y.

³Octadecyl trimethyl ammonium chloride, Armour Chemical Div., Chicago, Ill.

⁴Aliphatic amide, Armour Chemical Div.

⁵Alkyl sulfate, E. I. duPont de Nemours

⁶Glyco Products Co., Inc., New York, N. Y.

shape differences between treated and untreated metal; therefore, it could be assumed that the presence of a chemical impurity such as residual milling lubricant might reduce the segregation in the case of unphosphated aluminum. This conclusion appeared unfounded, however, as extreme leafing occurred when phosphated aluminum treated with acetone soluble surface impurities was incorporated into a slurry batch. Nevertheless, it is interesting to note that in subsequent tests sodium stearate, a possible mill contaminant, when applied from aqueous solution, did reduce leafing. The fact that sodium stearate is not highly soluble in acetone--the solvent used to perform the desired extractions--might explain the failure of the first tests.

None of the additives investigated, with the possible exception of the silicone, appeared to sensitize the final composition.

Impact tests were conducted on all samples except those in which extreme segregation precluded further consideration. At the 50% detonation point, drop heights ranged from 36 to 44 cm, as compared with a Composition B standard of 41 cm.⁷

Additional tests are in progress to evaluate more fully the physical and explosive properties of PEKN-1 compositions made using the described optimum modifications.

⁷Standard deviation: 2.4 cm.

NYLON-BONDED HMX COMBINATIONS

C. W. Falterman, H. D. Stanton,
H. J. Gryting and K. S. Skaar

One of the objectives of the Naval Ordnance Test Station fiscal year 1958 is a high-strength, high-detonation-velocity plastic-bonded explosive (PEX), one with a compressive strength of about 11,000 psi and a detonation velocity of about 8,700 m/sec. PEXN-2, which is 5-6%-by-weight nylon and the remainder 16-micron HMX, gives promise of fulfilling these physical requirements.

The specific need of Local Project 992 for a much more insensitive explosive with reasonable detonation velocity and high-strength prompted investigation of a nylon-HMX combination at high nylon contents.

The method of preparing the explosive molding powder and the preparation and testing of pellets have been described previously.¹ The impact sensitivity determination on small pellets has also been described.²

Nylon-HMX combinations (16-micron HMX) of 4.3, 5.2, 6.2, 10, 15, 29, and 50%-by-weight nylon were investigated. Their compressive strengths varied from 10,300 to 11,500 psi--strengths which compare very favorably with those for Composition B (1,300 psi), PEX 9404 (2,900 psi), and concrete (about 4,000 psi). Even though the compressive strengths of nylon-HMX combinations did not change much when the nylon-content was varied, the area under the compressive curves³ increased almost linearly from

¹Investigation of Nylon-HMX Plastic Bonded Explosive, by C. W. Falterman, H. D. Stanton, H. J. Gryting and K. S. Skaar. China Lake, Calif., NOTS, 9 July 1957. (NAVORD 5586, NOTS 1790), CONFIDENTIAL.

²PEX Progress for the Quarter Ending 30 June 1957, by The Explosives Division. China Lake, Calif., NOTS, July 1957. (TPR 194, NOTS 1816), CONFIDENTIAL.

³PEX Progress for the Quarter Ending 30 September 1957, by The Explosives Division. China Lake, Calif., NOTS, 12 Dec. 1957. (TPR 202, NOTS 1881), CONFIDENTIAL.

2.4-in.² with 6% nylon to about 15.3-in.² with 50% nylon. This area is a function which is probably a measure of how much energy the pellets will absorb before failing and is believed to be an indication that impact resistance increases almost linearly with nylon-content.

The impact sensitivities of nylon-HMX combinations as determined on the pellet form of the explosive are presented in Fig. 1, along with those of standard explosives.

These data indicate that the impact sensitivity decreases as the nylon-content is increased and that at about 20%-by-weight nylon the sensitivity appears to decrease more rapidly than before. The insensitivity of this composition with 32% nylon, determined on the pellet form, is about the same as that of TNT. The sensitivity determinations on the standard powder form of this PEK with 4.3 to 10% nylon suggested that it was even less sensitive than standard explosives.

Detonation velocities of 1/2-in.-diameter pellets pressed to 98% of theoretical maximum density (TMD) are presented as a function of nylon-content in Fig. 2, along with those of standard explosives.

The detonation velocity squared multiplied by the density (ρD^2) multiplied by a constant (1/4) is used as an estimation of the Chapman-Jouget pressure; this approximates the relative plate-acceleration. In Fig. 3 the plate-acceleration effectiveness of nylon-HMX combinations is compared to that of TNT by means of a ratio of their ρD^2 's. (The Jones formula is more precise than the ρD^2 approximation;⁴ it makes use of the change in detonation velocity with density:

$$P = \frac{\rho D^2}{(2 + \alpha) \left(1 + \frac{\rho}{D} \right) \left(\frac{\partial D}{\partial P}\right)} \quad \text{where } \alpha = \text{ideal value}$$

of $\gamma - 1 \approx 0.25$. The value of $\frac{\partial D}{\partial P}$ has not been determined, however, for the nylon-HMX explosive.)

⁴Suggested by Jacobs. See The Energy of Detonation, by Sigmund J. Jacobs. Naval Ordnance Laboratory, White Oak, Maryland. (NAVORD 4366) 17 September 1956, UNCLASSIFIED

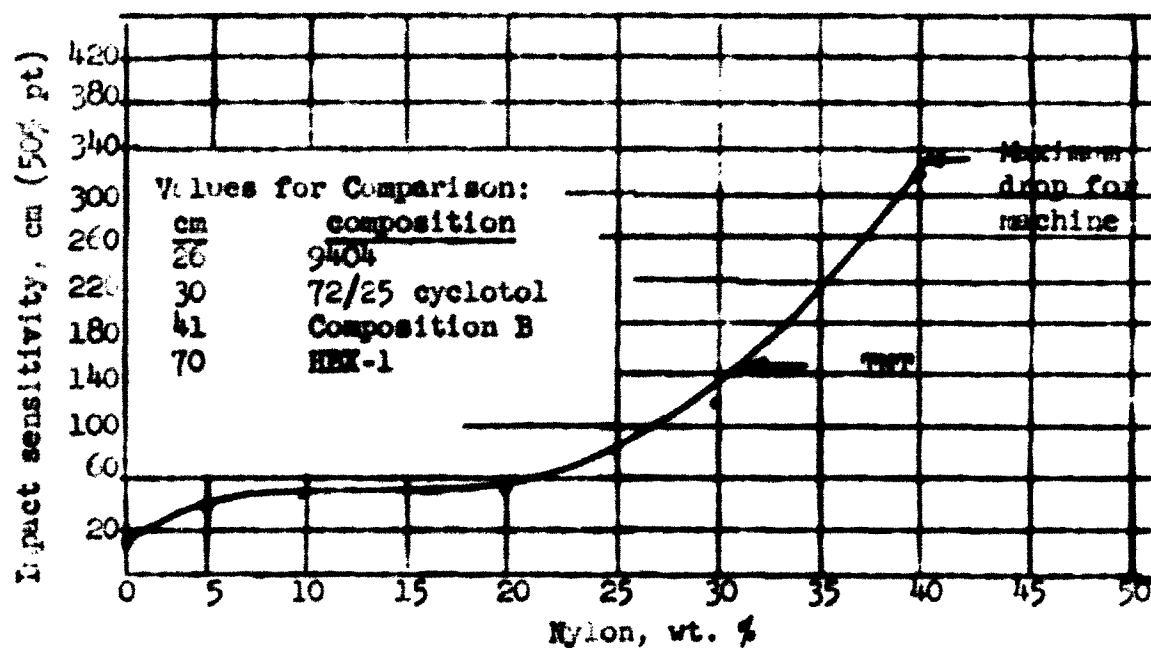


FIG. 1. Variation of Impact Sensitivity With Nylon-Content in Nylon-HMX Composition. (16-micron HMX)

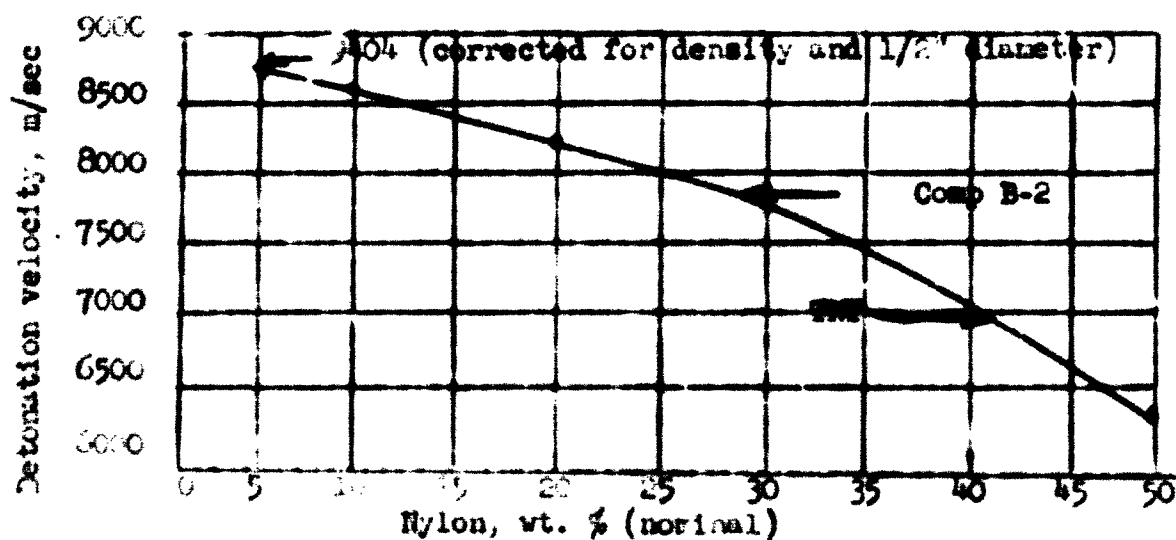


FIG. 2. Effect of Nylon-Content Variation on Detonation Velocity.

The curve in Fig. 3 suggests that a composition of about 60-65% HMX and the remainder nylon gives a detonation pressure equivalent to that of TNT. The data above appear to indicate that HMX can be combined with nylon of about 25%-by-weight to become about as insensitive as pressed TNT and yet retain explosive properties comparable to Composition B. It is believed that such an explosive will fill the specific need mentioned at the beginning of this report.

Some of these nylon-bonded HMX compositions appear to have high mechanical strength and reasonable resistance to detonation by impact. They also hold high promise for plate-acceleration, for continuous-rod fragmentation or shaped-charge warheads, or for any other application requiring a relatively rapid energy release (as contrasted to a metallized air-blast explosive). The nylon-content may be selected according to whether energy, or insensitivity, or impact strength is the most important property for a given application.

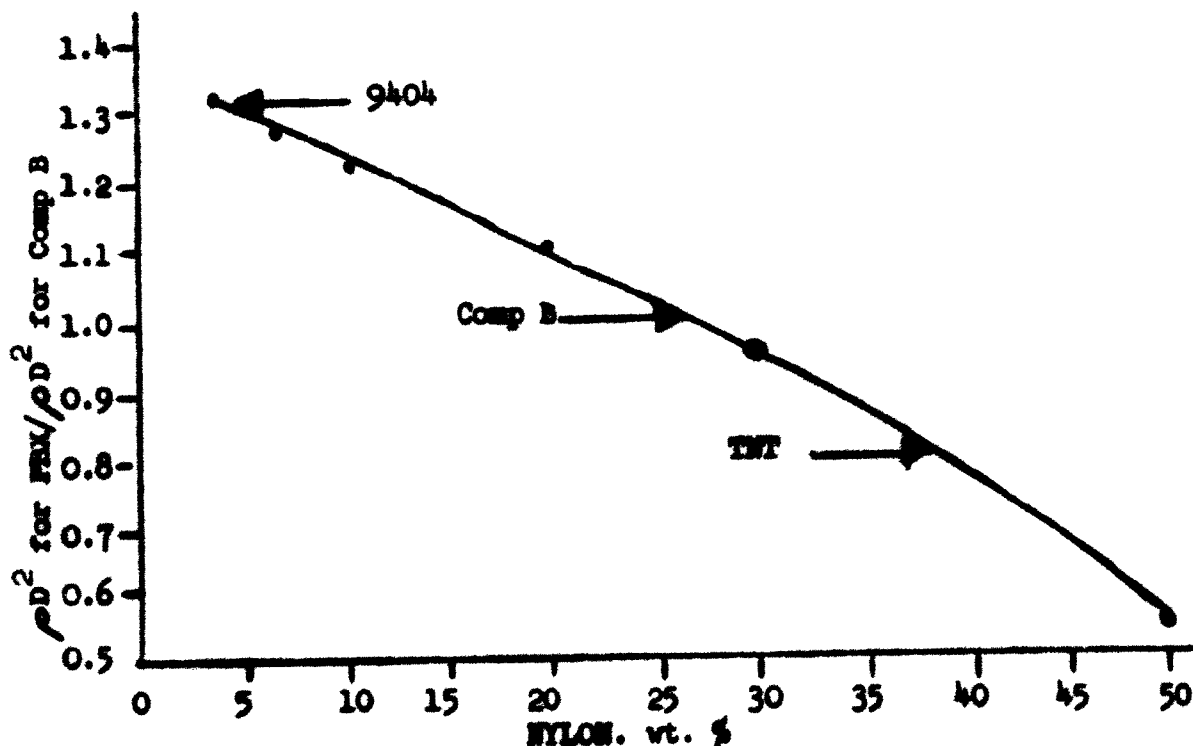


Fig. 3. Estimated Effect of Nylon-Content Variation on Relative Metal Acceleration.

HIGH-TEMPERATURE-RESISTANT EXPLOSIVE COMPOSITIONS

C. Douglas Lind, Peter L. Stang, Martin H. Kaufman

BACKGROUND

Aerodynamic heating of missiles in flight and which will be carried by "proposed" aircraft necessitates a high-temperature-resistant explosive composition. Even though the temperature attained by an internal component of a warhead may be less than skin temperature--how much less depending on insulation, type of heat sink, and time of exposure--the need for development of an explosive composition resistant to temperature up to 250°C (the skin temperature at Mach 3) is obvious.

It is expected that PBKN-1 will fill the need for an explosive resistant to temperatures up to about 150°C, the melting point of the nylon used. The nylon-HMX composition designated PBKN-2, described in the nylon-bonded HMX paper in this progress report, will withstand temperatures up to 150°C before melting and has an even higher autoignition temperature.

THE STUDY

TEMPERATURE-RESISTANT COMPONENTS

Binders. A survey of commercial temperature-resistant plastics indicated that several classes of plastics including fluorocarbons and silicones might be suitable for temperature-resistant compositions.

Explosives. A search of the A. D. Little punched-card compilation of known explosive compounds stable above 250°C yielded several promising explosives to be investigated including ammonium picrate, HMX, and guanylurea perchlorate.

INVESTIGATION

Several explosive compositions were prepared and evaluated. Guanylurea perchlorate, an impact-insensitive explosive with a high melting point, was found to undergo an exothermic reaction

at 195°C involving decomposition into a compound with decreased energy. Thus, this explosive might be useful only at temperatures below 195°C

HMX is stable at temperatures above 250°C; however, the effect of a solid-solid transformation at about 180°C needs to be examined.

Properties of Temperature-Resistant Compositions.

Autoignition-temperature-resistance and other properties for several temperature-resistant compositions which were investigated are given in Table 1. The composition which showed the most promise as to temperature-resistance without great energy loss was HMX/Kel-F 5500 Elastomer (90/10%-by-wt.), which has a detonation velocity and an impact sensitivity close to those of PBKN-2.

TABLE 1. Properties of High-Temperature-Resistant Explosives

Explosive Used:		Ammonium Picrate		
Binder Used:		Kel-F 5500	Silastic 400	
		Elastomer	Elastomer	
Composition	80/20	90/10	90/10	
Density, g/cm ³	--	1.650	--	
TMD, %	--	95.5	--	
Impact sensitivity, (50% pt), cm (2.5kg) ^a	153	123	139	
Autoignition temp., °C.	258-61	266-8	262-266	
Detonation velocity, m/sec	--	6901	--	
Plate dent (1/4-in. ball), in.	--	0.069	--	

Explosive Used:		EDX		
Binder Used:		Kel-F 5500	Silastic 400	Triallyl-
		Elastomer	Elastomer	cyanurate ^b
Composition	80/20	90/10	90/10	90/10
Density, g/cm ³	1.865	1.856	1.723	--
TMD, %	98.2	97.5	98.9	--
Impact sensitivity (50% pt), cm (2.5kg) ^a	42	32	32	29
Autoignition temp., °C	254-6	264-8	258-60	222-4
Detonation velocity, m/sec	8187	8586	8134	--
Plate dent (1/4-in. ball), in.	0.102	0.114	0.092	--

^aValues for 35-μg pellets with the Composition B, control chart, value 41 cm.

^bSolution polymerized and then mixed with explosive.

IMPROVEMENT OF THE BULK DENSITY OF PEKN-2 MOLDING POWDER

William Gordon

INTRODUCTION

It is relatively simple to prepare PEK molding powder on a laboratory scale and to press it into specimens for evaluation of its stability, physical properties and explosives characteristics. However, laboratory-scale molding powder usually lacks certain properties which are desirable from a production viewpoint, properties such as high bulk density and good control of particle-size. The lack of refined large-scale processing techniques for molding powder may account for the poor physical properties and sensitivity values obtained. Although impact sensitivities and strength may depend on preparation techniques, the explosive and stability characteristics will probably be unaffected by them.

To be considered practical for the preparation of molding powder, a process must consider certain properties of the powder itself. Some of these are uniformity of composition, uniformity of binder distribution, particle-size of the constituents, and particle-size and bulk density of the molding powder.

Bulk density is defined as the total mass per unit of total volume. Bulk density is not an intrinsic characteristic of the material but varies with the size-distribution of the particles and with the porosity of the particles. For a single nonporous particle, the true density equals the bulk density. High bulk density molding powder is very important for certain isostatic processing studies. This paper describes a method for obtaining a bulk density of approximately 1 g/cc for PEKN-2 molding powder.

THE STUDY

The bulk density of PEKN-1 and PEKN-2 molding powder prepared by original methods was low--in the range of 0.3 to 0.4 g/cc. A desirable bulk density would be 0.9 g/cc; however, at this time 0.7 g/cc would be considered acceptable.

There were two areas of approach toward possible improvement of bulk density: (1) coating the plastic-binder around the explosive crystals, which probably would be most important from the viewpoint of decreasing the porosity of the molding powder particles, and (2) modification of the equipment to obtain the proper size-distribution of the molding powder particles.

Exploratory efforts incorporating aspects of both these lines of investigation have recently produced PEKN-2 molding powder (5-6% nylon/95-94% HMX) with a bulk density ranging from 0.75 to 1.0 g/cc.

PREPARATION OF MOLDING POWDER

The technique used for the preparation of high-bulk-density PEKN-2 is essentially as follows:

1. The binder (nylon) is dissolved in methanol.
2. Sufficient toluene (an inert diluent) is added to bring the final weight ratio of nylon/methanol/toluene to 1/3/4.
3. HMX containing approximately 15% water is added to the binder solution and the resultant slurry is mixed for 30 minutes. At the end of this period the nylon, apparently, has partially precipitated.
4. This "curded mud" is then transferred to a dispersion kettle filled with water/methanol (2/1 weight ratio) and a small amount of a nitrate compound, where it is dispersed into molding powder particles.

A somewhat similar technique was tried by S. Wright, Holston Defense Corporation. However, it involved the use of toluene in the dispersing liquid to produce a two-phase system, and, so far as is known at NOTS, results of this early experimentation were inconclusive.

PHYSICAL CHEMISTRY STUDIES

It was thought that the two most important ways to reduce porosity would be to control precipitation of the nylon from the binder solution (since this would probably affect the porosity of the nylon-coated explosive particle) and the concentration of the binder solution (since this would affect the amount of solvent to be diffused out from within the nylon envelope around the PEK particle).

Laboratory work showed that when nylon is precipitated from a methanol solution it passes through a tacky stage prior to assuming its final hardened state. This tacky stage is probably the period during which the PEX particles agglomerate into large unworkable pieces; and it appeared reasonable to assume that if the duration of the tacky stage could be controlled the amount of agglomeration could be controlled. By use of water containing 2% nitric acid, the rate of precipitation of the nylon was accelerated and there was much less agglomeration of the particles into an unworkable mass.

At the same time tests were made to determine the minimum amount of solvent necessary for the slurry process, so as to reduce the quantity of solvent which must diffuse from within the nylon envelope around the explosive. It was found possible to produce a concentrated solution of 1 part nylon to 3 parts methanol; however, this solution was not thin enough to coat the explosive particles when the solution was added to the binder solution for mixing. A solution of one part nylon to seven parts methanol is required to mix the explosive adequately in the binder solution in the mixing kettle. Therefore, a solution of nylon/methanol/toluene in the ratio 1/3/4 was used for mixing the explosive with the binder. The toluene was used as a diluent for the nylon-methanol solution.

The use of toluene as a diluent in which nylon is not soluble is practical only for ratios of the magnitude listed in the preceding paragraph. Addition of toluene in greater ratios caused the nylon to precipitate out of solution.

When the HMX containing approximately 15% water was added to the nylon-methanol-toluene solution and was mixed, the nylon partially precipitated out of solution and formed little globules of PEX. These globules were not tacky; they appeared to be capable of retaining their individuality throughout the mixing process.

Thus, to recapitulate, when HMX is added to a 1/3/4 nylon/methanol/toluene solution and mixed, and when subsequently two parts of water for each part of nylon are added, a PEX particle of the type desired begins to take form.

EQUIPMENT MODIFICATIONS

Two important variables producing a PEX molding powder with proper particle size-distribution are better flow pattern and shear distribution in the dispersion step of the slurry process.

Figure 1 is a schematic diagram of the kettles presently used for mixing and dispersion.

Previously, both the mixing step and the dispersion of explosive suspended in the binder solution were performed in the mixing kettle. The mixing kettle was not satisfactory for the dispersion step because the flow pattern and shear forces were such that the material around the turbine blade tended to agglomerate in very large particles, while only a small amount of the material was sufficiently dispersed as to be in the desired particle-size range. When the speed of the agitator was increased to reduce the amount of agglomerate in the turbine blade region, a proportional amount of the material in the desired particle-size range was reduced to an undesirably fine particle-size. The dispersion kettle, on the other hand (based on a limited amount of experimentation) appeared to have both a more desirable flow pattern and better control over the shearing forces acting upon the dispersed particles.

INTERMEDIATE-SCALE BATCHES

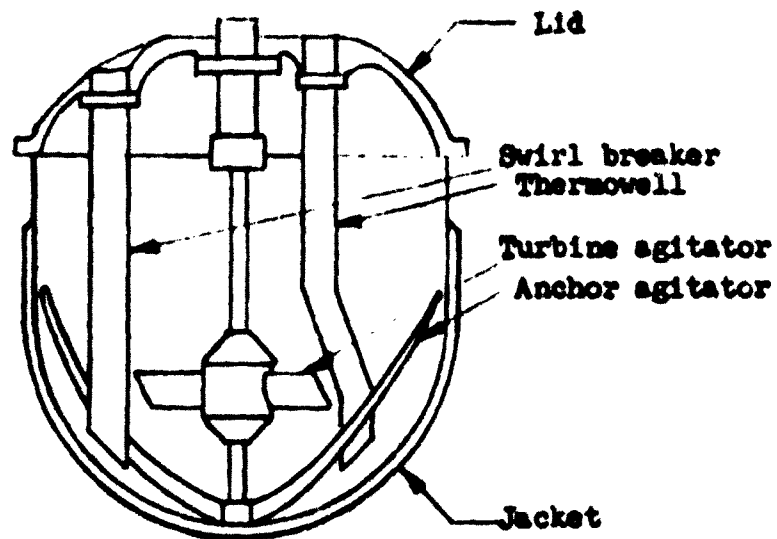
Three 25-lb batches were made to test effects of using (1) methanol-toluene solvent for the nylon binder, (2) the mixing kettle to mix the explosive in the binder solution, and (3) the dispersion kettle to precipitate the nylon out of the solution around the explosive crystals and to disperse the PBX particles as they were formed. Each time the binder solution and wet explosive (containing approximately 15% water) were mixed in the mixing kettle, at the end of the remote period it was noted that the binder solution--explosive "mud"--had coagulated into curdy particles. Following the mixing period, the explosive-binder-solution mixture was removed from the mixing kettle and put into the dispersing kettle, which contained a 2% nitric acid-water solution and was agitated at approximately 75 rpm. The ratio of dispersion liquid to binder solvent was 6.5/1. It was noted that the curdy explosive-binder-solution mixture immediately broke down into fine particles. During filtering, the PBX was found to be 75% fine (see Fig. 2) and 25% of a more desirable particle-size (see Fig. 3).

Preliminary laboratory testing of the intermediate-scale molding powder batches showed that some degree of coating was achieved; an impact sensitivity value of 30-33 cm was obtained at the 50% detonation point (as compared to 19 cm for pure HMX). Small pellets, of 1/2-inch diameter and 3/4-inch length, pressed from fine-particle molding powder could be compacted to only 95--97% of TMD, however, and compressive strengths of only 5,000 to 6,000 psi resulted. It

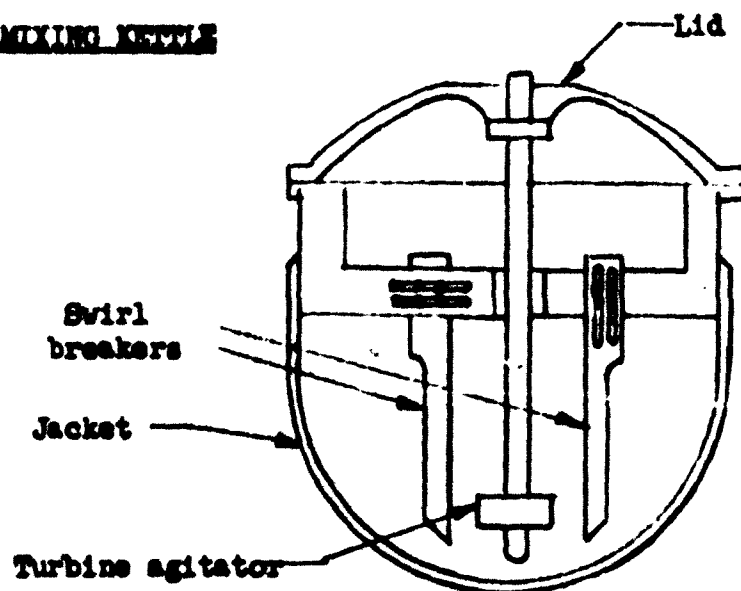
It is thought that a possible reason for the low density and compressive strength may be the degradation of the nylon by the acid in the dispersion water. Laboratory work by Barbara Stott on PEKN-1 has indicated that nitrate salts, which probably do not harm nylon, may be used in place of nitric acid to accelerate the precipitation of nylon.

CONCLUSIONS

A high bulk density PEKN-2 molding powder has been produced. Although the molding powder is not entirely what is desired--since it is too fine and the particle-size control is poor--it does show that attainment of a nylon/PMMA molding powder with bulk density of 0.9 to 1.0 g/cc is possible.



MIXING KETTLE



DISPERSION KETTLE

FIG. 1. Schematic of Mixing and Dispersion Kettles.

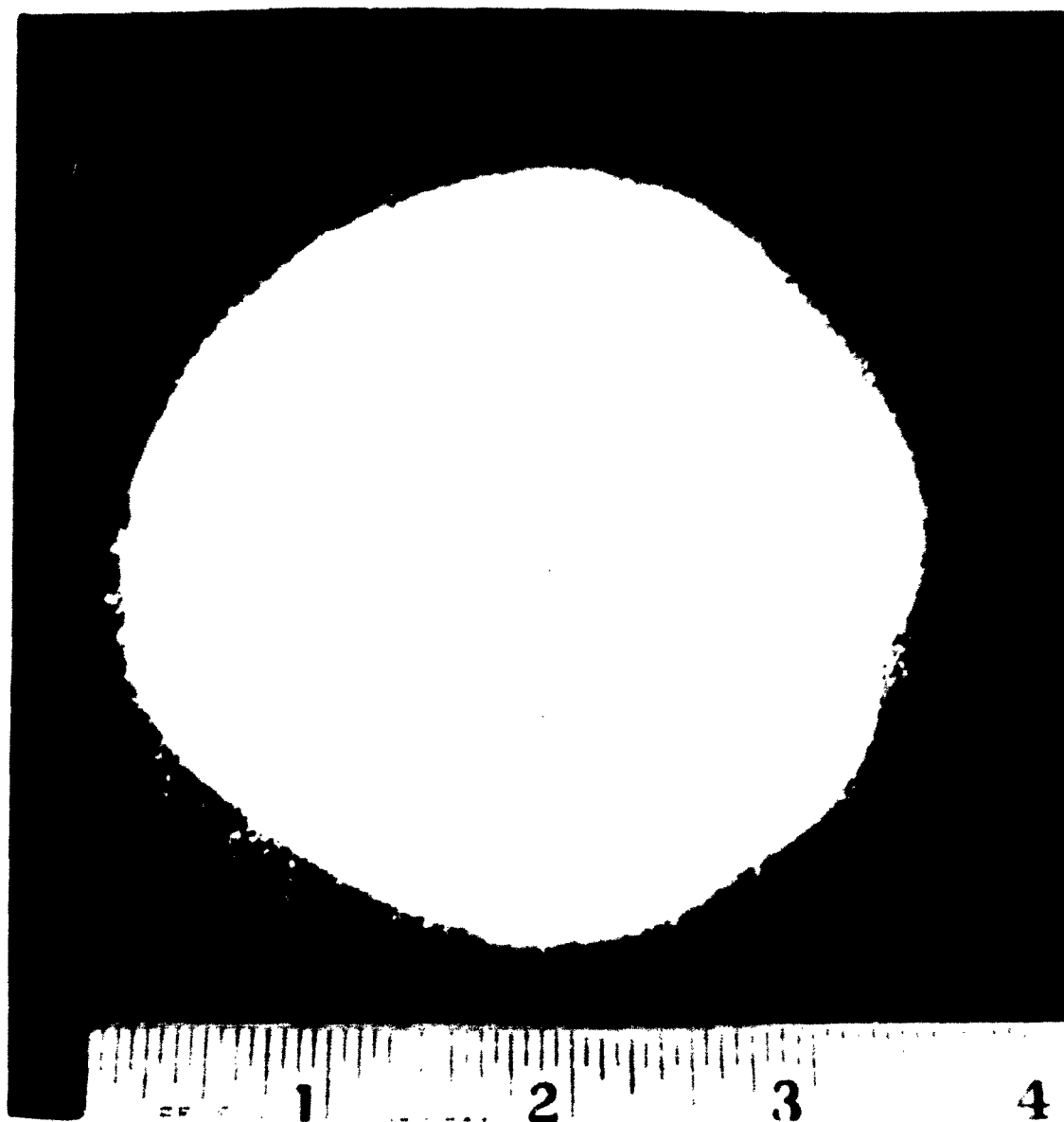


FIG. 2. Fine Particle-Size PBXN-2.

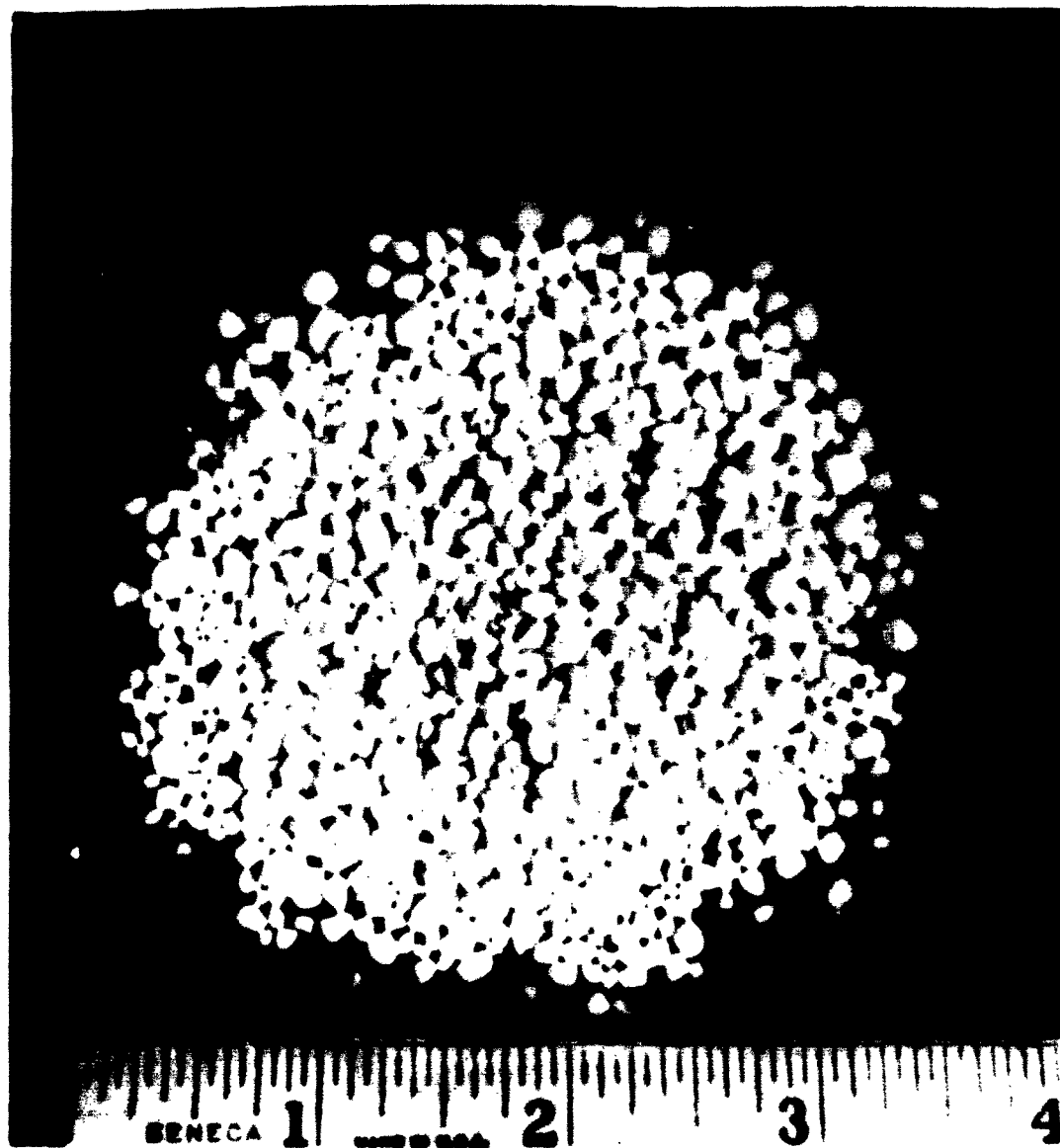


FIG. 3. Desirable Particle-Size PBXII-2.

- 1 Deputy for Material, Langley Air Force Base (Director of Armament)
- 2 Wright Air Development Center, Wright-Patterson Air Force Base (WCOSI)
- 5 Armed Services Technical Information Agency (TICSCP-4)
- 1 Bureau of Mines, Pittsburgh (Division of Explosive Technology, Documents Librarian)
- 2 Allegany Ballistics Laboratory, Cumberland, Md.
- 1 Arthur D. Little, Inc., Cambridge
- 1 Hercules Research Center, Wilmington (A. M. Ball)
- 1 Jet Propulsion Laboratory, CIT, Pasadena (Dr. W. H. Pickering)
- 1 Lockheed Aircraft Corporation, Missile Systems Division, Van Nuys, Calif. (E. Robertson)
- 1 Los Alamos Scientific Laboratory (GMX-2)
- 1 National Northern Corporation, West Hanover, Mass. (S. J. Porter)
- 1 Purdue University, Lafayette, Ind. (E. T. McBee, Department of Chemistry)
- 1 Rohm & Haas Company, Redstone Arsenal Research Division (Librarian)
- 1 Stanford Research Institute, Poulter Laboratories, Menlo Park Calif.
- 1 The Martin Company, Baltimore (I. E. Tuhy)
- 6 University of California Radiation Laboratory, Technical Information Division, Livermore (C. G. Craig)
 - Dr John S. Foster (1)
 - Marvin Martin (1)
 - W. B. Reynolds (1)
 - Kenneth Street (1)
 - Dr. H. F. York/Duane Sewell (1)
- 1 University of Denver, Denver Research Institute (D. K. Parks)
- 1 University of Utah, Salt Lake City (Prof. M. A. Cook)